

WHAT IS CLAIMED IS:

1                   1.       A luminal prosthesis comprising:  
2                   a scaffold which is implantable within a body lumen; and  
3                   means on the scaffold for releasing a substance, wherein the substance is  
4 released over a predetermined time pattern comprising an initial phase wherein a substance  
5 delivery rate is below a threshold level and a subsequent phase wherein the substance  
6 delivery rate is above a threshold level.

1                   2.       A luminal prosthesis as in claim 1, wherein the scaffold is a stent or  
2 graft.

1                   3.       A luminal prosthesis as in claim 1, wherein the scaffold is implantable  
2 in a blood vessel.

1                   4.       A luminal prosthesis as in claim 1, wherein the substance comprises at  
2 least one agent selected from the group consisting of immunosuppressant agent, anti-  
3 inflammatory agent, anti-proliferative agent, anti-migratory agent, anti-fibrotic agent, anti-  
4 thrombotic agent, anti-platelet agent, and I Ib/IIIa agent.

1                   5.       A luminal prosthesis as in claim 4, wherein the agent is at least one  
2 immunosuppressant agent selected from the group consisting of mycophenolic acid,  
3 rapamycin, cyclosporine A, cycloheximide, cyclophosphamide, mizoribine,  
4 methylprednisolone, azathioprine, ribovirin, FK506, tiazofurin, methotrexate, zafurin, and  
5 mycophenolate mofetil.

1                   6.       A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises a matrix formed over at least a portion of the scaffold.

1                   7.       A luminal prosthesis as in claim 6, wherein the matrix is composed of  
2 a material which undergoes degradation in a vascular environment.

1                   8.       A luminal prosthesis as in claim 7, wherein the matrix degrades by  
2 surface degradation.

1                   9.       A luminal prosthesis as in claim 7, wherein the matrix degrades by  
2 bulk degradation.

- 1 10. A luminal prosthesis as in claim 7, wherein the matrix is a copolymer  
2 of poly-l-lactic acid and poly-e-caprolactone.
- 1 11. A luminal prosthesis as in claim 6, wherein the matrix is composed of  
2 a nondegradable material.
- 1 12. A luminal prosthesis as in claim 11, wherein the nondegradable matrix  
2 comprises cellulose acetate butyrate.
- 1 13. A luminal prosthesis as in claim 6, wherein the substance is disposed  
2 within the matrix in a pattern that provides the desired release rates.
- 1 14. A luminal prosthesis as in claim 6, wherein the substance is on or  
2 within the scaffold adjacent the matrix in a pattern that provides the desired release rates.
- 1 15. A luminal prosthesis as in claim 6, wherein the matrix comprises  
2 multiple layers, each layer containing a different, same, or no substance.
- 1 16. A luminal prosthesis as in claim 6, further comprising a rate limiting  
2 barrier coupled to the matrix.
- 1 17. A luminal prosthesis as in claim 6, further comprising a rate limiting  
2 barrier formed over the matrix.
- 1 18. A luminal prosthesis as in claim 16 or 17, wherein the substance is  
2 released by diffusion through the barrier.
- 1 19. A luminal prosthesis as in claim 6, further comprising a biocompatible  
2 layer coupled to the matrix.
- 1 20. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises a rate limiting barrier formed over at least a portion of the scaffold.
- 1 21. A luminal prosthesis as in claim 20, wherein the rate limiting barrier  
2 has a sufficient thickness so that release of the substance from the barrier begins substantially  
3 after a preselected time period.

1                   22.     A luminal prosthesis as in claim 20, wherein the barrier has a thickness  
2     in a range from 0.01 micron to 100 microns.

1                   23.     A luminal prosthesis as in claim 20, wherein the barrier is composed of  
2     at least one material selected from the group consisting of silicone, polytetrafluoroethylene,  
3     parylast, polyurethane, and paralene.

1                   24.     A luminal prosthesis as in claim 20, wherein the barrier comprises  
2     multiple layers, each layer containing a different, same, or no substance.

1                   25.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises a reservoir on or within the scaffold containing the substance and a  
3     cover over the reservoir, wherein the cover is at least partially degradable over a preselected  
4     time period so that release of the substance from the reservoir begins substantially after the  
5     preselected time period.

1                   26.     A luminal prosthesis as in claim 25, wherein the cover is a polymer  
2     matrix.

1                   27.     A luminal prosthesis as in claim 25, further comprising a rate limiting  
2     barrier formed between the reservoir and the cover.

1                   28.     A luminal prosthesis as in claim 25, further comprising a rate limiting  
2     barrier coupled to the cover.

1                   29.     A luminal prosthesis as in claim 27 or 28, wherein the substance is  
2     released by diffusion through the barrier.

1                   30.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises a reservoir on or within the scaffold containing the substance and a  
3     cover over the reservoir.

1                   31.     A luminal prosthesis as in claim 30, wherein the cover having a  
2     sufficient thickness so that release of the substance from the reservoir begins substantially  
3     after a preselected time period.

1                    32.     A luminal prosthesis as in claim 30, wherein the cover is a  
2     nondegradable matrix.

1                    33.     A luminal prosthesis as in claim 30, wherein the cover is a rate limiting  
2     barrier.

1                    34.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises a reservoir on or within the scaffold containing the substance and an  
3     external energy source for directing energy at the prosthesis after implantation to effect  
4     release of the substance.

1                    35.     A luminal prosthesis as in claim 34, further comprising a matrix over  
2     the reservoir.

1                    36.     A luminal prosthesis as in claim 34, further comprising a rate limiting  
2     barrier over the reservoir.

1                    37.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises a matrix formed over at least a portion of the scaffold, wherein the  
3     substance is disposed adjacent or within the matrix, and an external energy source for  
4     directing energy at the prosthesis after implantation to effect release of the substance.

1                    38.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises a rate limiting barrier formed over at least a portion of the scaffold,  
3     wherein the substance is disposed adjacent or within the barrier, and an external energy  
4     source for directing energy at the prosthesis after implantation to effect release of the  
5     substance.

1                    39.     A luminal prosthesis as in any of claims 34, 37, or 38, wherein the  
2     energy source is at least one of ultrasound, magnetic resonance imaging, magnetic field, radio  
3     frequency, temperature change, electromagnetic, x-ray, radiation, heat, gamma, or  
4     microwave.

1                    40.     A luminal prosthesis as in claim 1, wherein the means for releasing the  
2     substance comprises magnetic particles coupled to the substance or the scaffold and a

3 magnetic source for directing a magnetic field at the prosthesis after implantation to effect  
4 release of the substance.

1 41. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises magnetic particles coupled to a matrix formed over the scaffold and a  
3 magnetic source for directing a magnetic field at the prosthesis after implantation to effect  
4 release of the substance.

1 42. A luminal prosthesis as in claim 41, wherein the substance is disposed  
2 adjacent or within the matrix.

1 43. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises magnetic particles coupled to a rate limiting barrier formed over the  
3 scaffold and a magnetic source for directing a magnetic field at the prosthesis after  
4 implantation to effect release of the substance.

1 44. A luminal prosthesis as in claim 43, wherein the substance is disposed  
2 adjacent or within the barrier.

1 45. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises a change in a pH to effect release of the substance.

1 46. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises a reservoir on or within the scaffold containing the substance and  
3 vibrational or heating energy directed at the prosthesis after implantation to effect release of  
4 the substance.

1 47. A luminal prosthesis as in claim 1, wherein the means for releasing the  
2 substance comprises at least a matrix or rate limiting barrier formed over the scaffold  
3 containing the substance and vibrational or heating energy directed at the prosthesis after  
4 implantation to effect release of the substance.

1 48. A luminal prosthesis as in claim 1, wherein the initial phase of  
2 substance delivery is less than 12 weeks.

1 49. A luminal prosthesis as in claim 1, wherein the initial phase of  
2 substance delivery is within a time period of 1 hour to 8 weeks.

- 1 50. A luminal prosthesis as in claim 1, wherein the initial phase of  
2 substance delivery is within a time period of 12 hours to 2 weeks.
- 1 51. A luminal prosthesis as in claim 1, wherein the initial phase of  
2 substance delivery is within a time period of 1 day to 1 week.
- 1 52. A luminal prosthesis as in claim 1, wherein the subsequent phase of  
2 substance delivery is within a time period of 4 hours to 24 weeks.
- 1 53. A luminal prosthesis as in claim 1, wherein the subsequent phase of  
2 substance delivery is within a time period of 1 day to 12 weeks.
- 1 54. A luminal prosthesis as in claim 1, wherein the subsequent phase of  
2 substance delivery is within a time period of 2 days to 8 weeks.
- 1 55. A luminal prosthesis as in claim 1, wherein the subsequent phase of  
2 substance delivery is within a time period of 3 days to 50 days.
- 1 56. A luminal prosthesis as in claim 1, wherein the substance delivery rate  
2 at the initial phase is between 0  $\mu\text{g/day}$  to 50  $\mu\text{g/day}$ .
- 1 57. A luminal prosthesis as in claim 1, wherein the substance delivery rate  
2 at the initial phase is between 5  $\mu\text{g/day}$  to 30  $\mu\text{g/day}$ .
- 1 58. A luminal prosthesis as in claim 1, wherein the substance delivery rate  
2 at the subsequent phase is between 5  $\mu\text{g/day}$  to 200  $\mu\text{g/day}$ .
- 1 59. A luminal prosthesis as in claim 1, wherein the substance delivery rate  
2 at the subsequent phase is between 10  $\mu\text{g/day}$  to 100  $\mu\text{g/day}$ .
- 1 60. A luminal prosthesis as in claim 1, wherein a mammalian tissue  
2 concentration of the substance at the initial phase is within a range from 0  $\mu\text{g/mg}$  of tissue to  
3 100  $\mu\text{g/mg}$  of tissue.
- 1 61. A luminal prosthesis as in claim 1, wherein a mammalian tissue  
2 concentration of the substance at the initial phase is within a range from 0  $\mu\text{g/mg}$  of tissue to  
3 10  $\mu\text{g/mg}$  of tissue.

1                   62.     A luminal prosthesis as in claim 1, wherein a mammalian tissue  
2 concentration of the substance at the subsequent phase is within a range from 1 picogram/mg  
3 of tissue to 100 µg/mg of tissue.

1                   63.     A luminal prosthesis as in claim 1, wherein a mammalian tissue  
2 concentration of the substance at the subsequent phase is within a range from 1 nanogram/mg  
3 of tissue to 10 µg/mg of tissue.

1                   64.     An improved method for delivering a pharmacological agent to an  
2 artery, said method being of the type where a prosthesis is implanted within the artery and the  
3 prosthesis releases the pharmacological agent, wherein the improvement comprises  
4 implanting a prosthesis that is programmed to begin substantial release of the  
5 pharmacological agent beginning after growth of at least one layer of cells over a part of the  
6 prosthesis.

1                   65.     A method as in claim 64, wherein the cells comprise inflammatory,  
2 smooth muscle, or endothelial cells.

1                   66.     A method as in claim 64, wherein the pharmacological agent  
2 comprises at least one agent selected from the consisting of immunosuppressant agent, anti-  
3 inflammatory agent, anti-proliferative agent, anti-migratory agent, anti-fibrotic agent, anti-  
4 thrombotic agent, anti-platelet agent, and IIb/IIIa agent.

1                   67.     A method for luminal substance delivery, said method comprising:  
2 providing a luminal prosthesis incorporating or coupled to the substance,  
3 wherein the prosthesis contains a matrix which undergoes degradation in a vascular  
4 environment; and  
5 implanting the prosthesis in a body lumen so that at least a portion of the  
6 matrix degrades over a predetermined time period and substantial substance release begins  
7 after the matrix substantially begins to degrade.

1                   68.     A method as in claim 67, wherein the substance is incorporated in a  
2 reservoir in or on a scaffold and the reservoir is covered by the matrix so that substantial  
3 substance release begins after the matrix has degraded sufficiently to uncover the reservoir.

1                    69.     A method as in claim 67, wherein the substance is contained in the  
2     matrix and the matrix coats a scaffold, wherein an outer layer of the matrix is substantially  
3     free from the substance so that substance release will not substantially begin until the outer  
4     layer has degraded.

1                    70.     A method as in claim 67, wherein the substance is contained within or  
2     on a scaffold coated by the matrix.

1                    71.     A method as in claim 67, wherein the prosthesis is coated with the  
2     matrix by spraying, dipping, deposition, or painting.

1                    72.     A method as in claim 67, wherein the prosthesis incorporates the  
2     substance by coating, spraying, dipping, deposition, or painting the substance on the  
3     prosthesis.

1                    73.     A method as in claim 67, wherein the matrix is a polymer.

1                    74.     A method as in claim 67, wherein the matrix comprises multiple  
2     layers, each layer containing a different, same, or no substance.

1                    75.     A method as in claim 67, wherein the prosthesis contains a rate  
2     limiting barrier adjacent the matrix coating.

1                    76.     A method as in claim 67, wherein the matrix degrades by surface  
2     degradation.

1                    77.     A method as in claim 67, wherein the matrix degrades by bulk  
2     degradation.

1                    78.     A method for luminal substance delivery, said method comprising:  
2     providing a luminal prosthesis incorporating and/or coupled to the substance,  
3     wherein the prosthesis contains a rate limiting barrier; and  
4     implanting the prosthesis in a body lumen so that substantial substance release  
5     from the barrier begins after a preselected time period.

1                    79.     A method as in claim 78, wherein the barrier has a sufficient thickness  
2     to allow diffusion of the substance through the barrier.



1           80.    A method for luminal substance delivery, said method comprising:  
2           providing a luminal prosthesis incorporating or coupled to the substance,  
3    wherein the prosthesis contains a nondegradable matrix; and  
4           implanting the prosthesis in a body lumen so that substantial substance release  
5    from the nondegradable matrix begins after a preselected time period.

1           81.    A method as in claim 80, wherein the nondegradable matrix has a  
2    sufficient thickness to allow diffusion of the substance through the nondegradable matrix.

1           82.    A method as in any of claims 67-81, wherein substantial release of the  
2    substance begins within a time period of 4 hours to 24 weeks in a vascular environment.

1           83.    A method as in any of claims 67-81, wherein substantial release of the  
2    substance begins within a time period of 1 day to 12 weeks in a vascular environment.

1           84.    A method as in any of claims 67-81, wherein substantial release of the  
2    substance begins within a time period of 2 days to 8 weeks in a vascular environment.

1           85.    A method as in any of claims 67-81, wherein substantial release of the  
2    substance begins within a time period of 3 days to 50 days in a vascular environment.

1           86.    A method for luminal substance delivery, said method comprising:  
2           implanting a luminal prosthesis in a lumen of a patient, wherein the prosthesis  
3    incorporates and/or couples a substance to be released into the lumen or a luminal wall; and  
4           directing energy at the prosthesis to effect release of the substance from the  
5    prosthesis.

1           87.    A method as in claim 86, wherein the prosthesis incorporates the  
2    substance by coating, spraying, dipping, deposition, or painting the substance on the  
3    prosthesis.

1           88.    A method as in claim 86, wherein the substance is incorporated in a  
2    reservoir in or on a scaffold containing the substance.

1           89.    A method as in claim 86, wherein the substance is incorporated in a  
2    matrix and the matrix coats a scaffold.

1                    90.     A method as in claim 86, wherein the energy is at least one of  
2     ultrasound, magnetic resonance imaging, magnetic field, radio frequency, temperature  
3     change, electromagnetic, x-ray, radiation, heat, gamma, or microwave.

1                    91.     A method for releasing a substance from an implanted device, said  
2     method comprising:  
3                    implanting a device in a patient, wherein the device incorporates magnetic  
4     particles coupled to the substance; and  
5                    directing a magnetic field at the device to effect release of the substance from  
6     the device.

1                    92.     A method for releasing a substance from an implanted device, said  
2     method comprising:  
3                    implanting a device in a patient, wherein the device incorporates magnetic  
4     particles coupled to a matrix formed over the device; and  
5                    directing a magnetic field at the device to effect release of the particles from  
6     the device.

1                    93.     A method for releasing a substance from an implanted device, said  
2     method comprising:  
3                    implanting a device in a patient, wherein the device incorporates magnetic  
4     particles coupled to a rate limiting barrier formed over the device; and  
5                    directing a magnetic field at the device to effect release of the particles from  
6     the device.

1                    94.     A kit comprising:  
2                    a luminal prosthesis; and  
3                    instructions on how to implant the prosthesis for luminal substance delivery  
4     according to any one of claims 64-93.

1                    95.     A luminal prosthesis comprising:  
2                    a scaffold which is implantable within a body lumen; and  
3                    means on the scaffold for releasing two substances, wherein the two  
4     substances are released over two predetermined time patterns comprising an initial phase

5 wherein a substance delivery rate is below a threshold level and a subsequent phase wherein  
6 the substance delivery rate is above a threshold level.

1 96. A prosthesis as in claim 95, wherein the means for releasing the two  
2 substances comprises a matrix having multiple layers formed over at least a portion of the  
3 scaffold.

1 97. A prosthesis as in claim 95, wherein the means for releasing the two  
2 substances comprises a rate limiting barrier having multiple layers formed over at least a  
3 portion of the scaffold.

1 98. A prosthesis as in claim 95, wherein the two substances are released at  
2 different time patterns.

1 99. A prosthesis as in claim 95, wherein a second substance is released  
2 after a threshold level of a first substance is reached.

1 100. A prosthesis as in claim 95, wherein the two substances are released  
2 simultaneously.

1 101. A prosthesis as in claim 95, wherein the two substances are  
2 sequentially released.